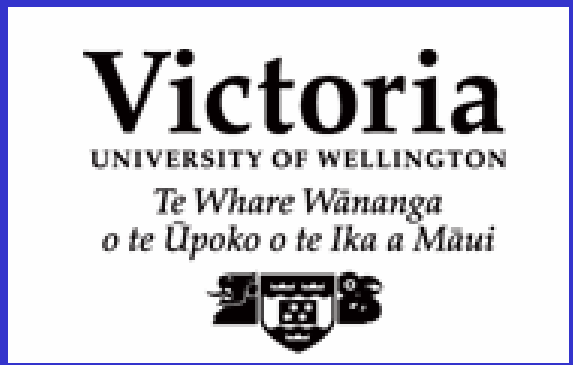
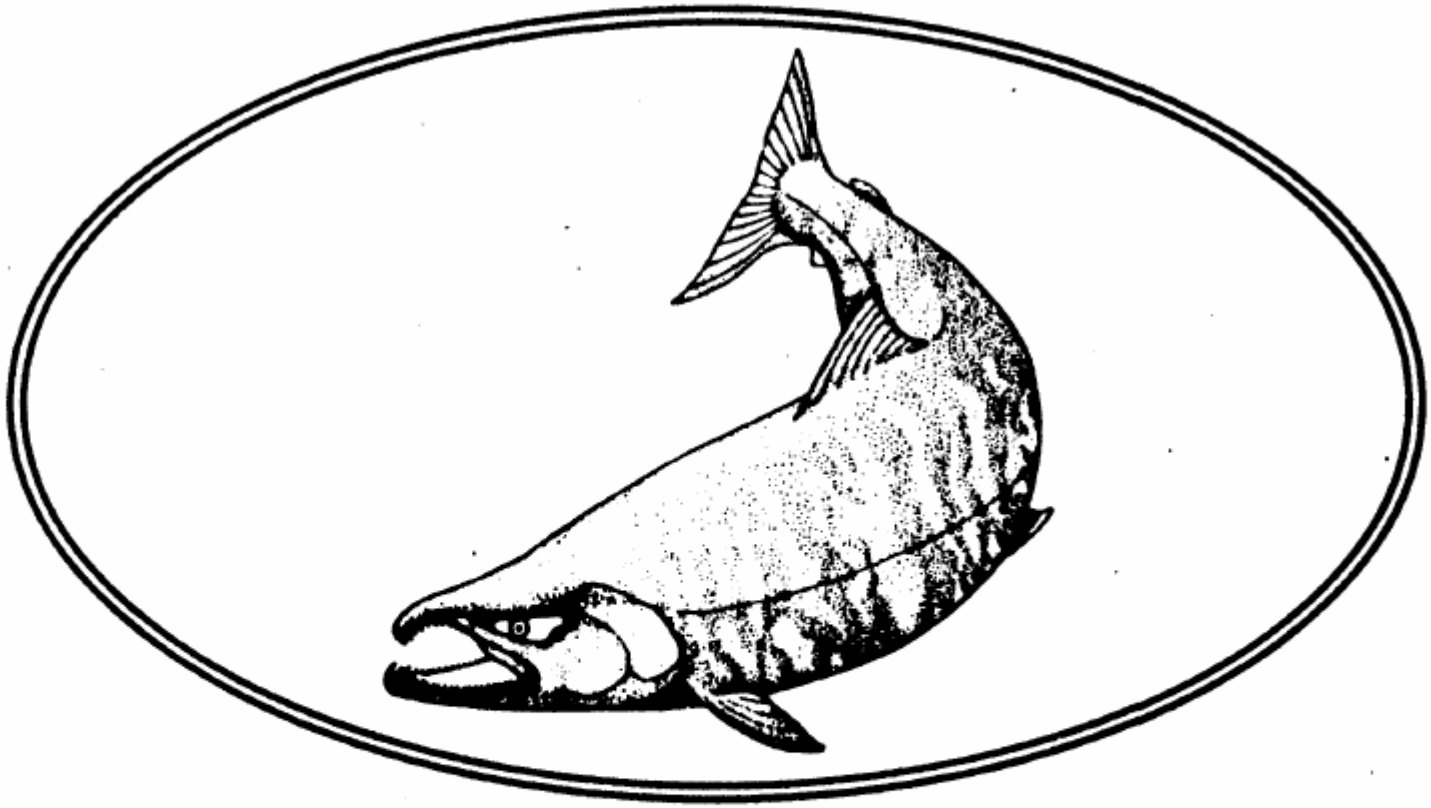
Genetics Primer: Introduction

Fred Allendorf





Conservation and Genetics of Salmonid Fishes

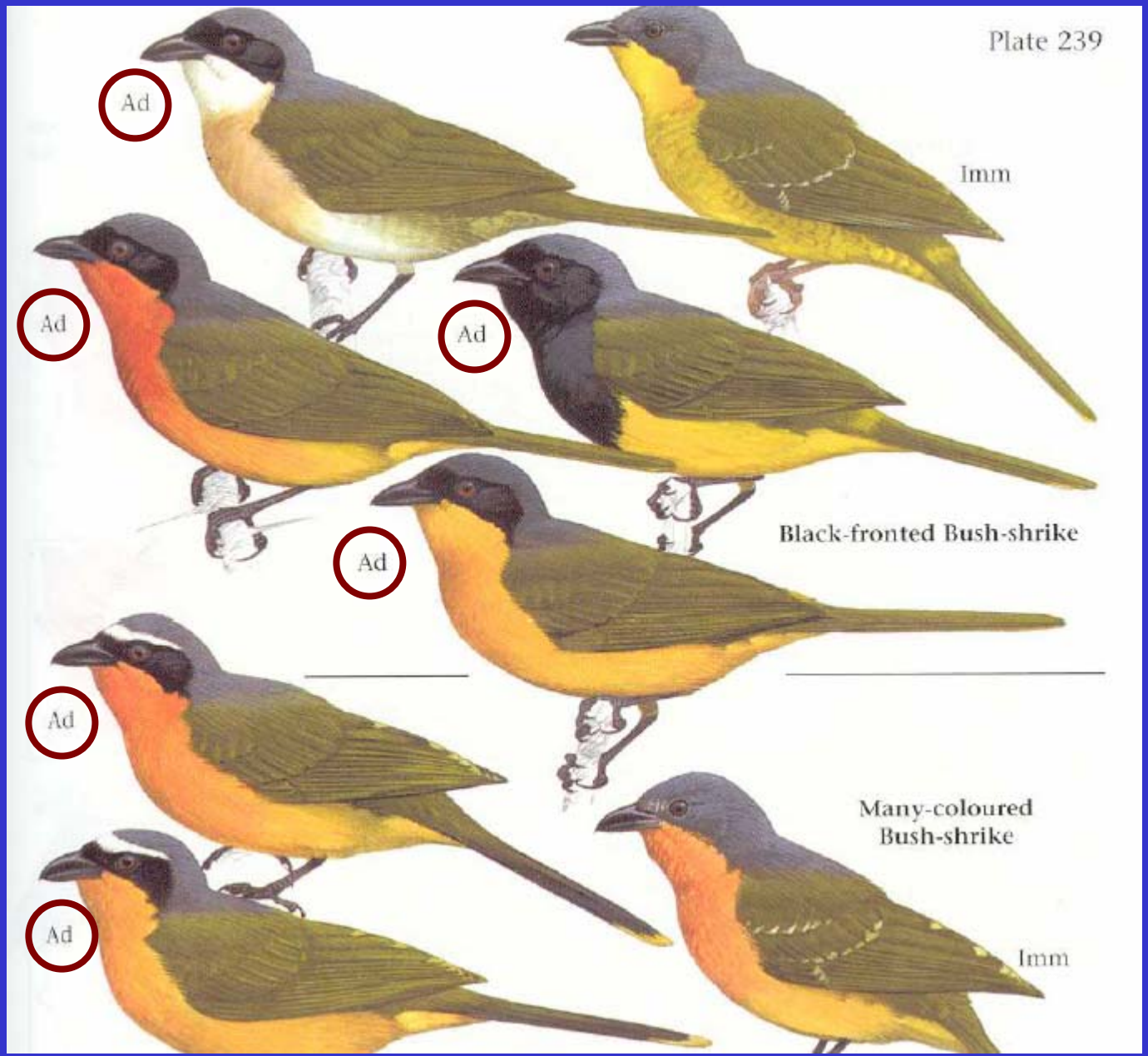
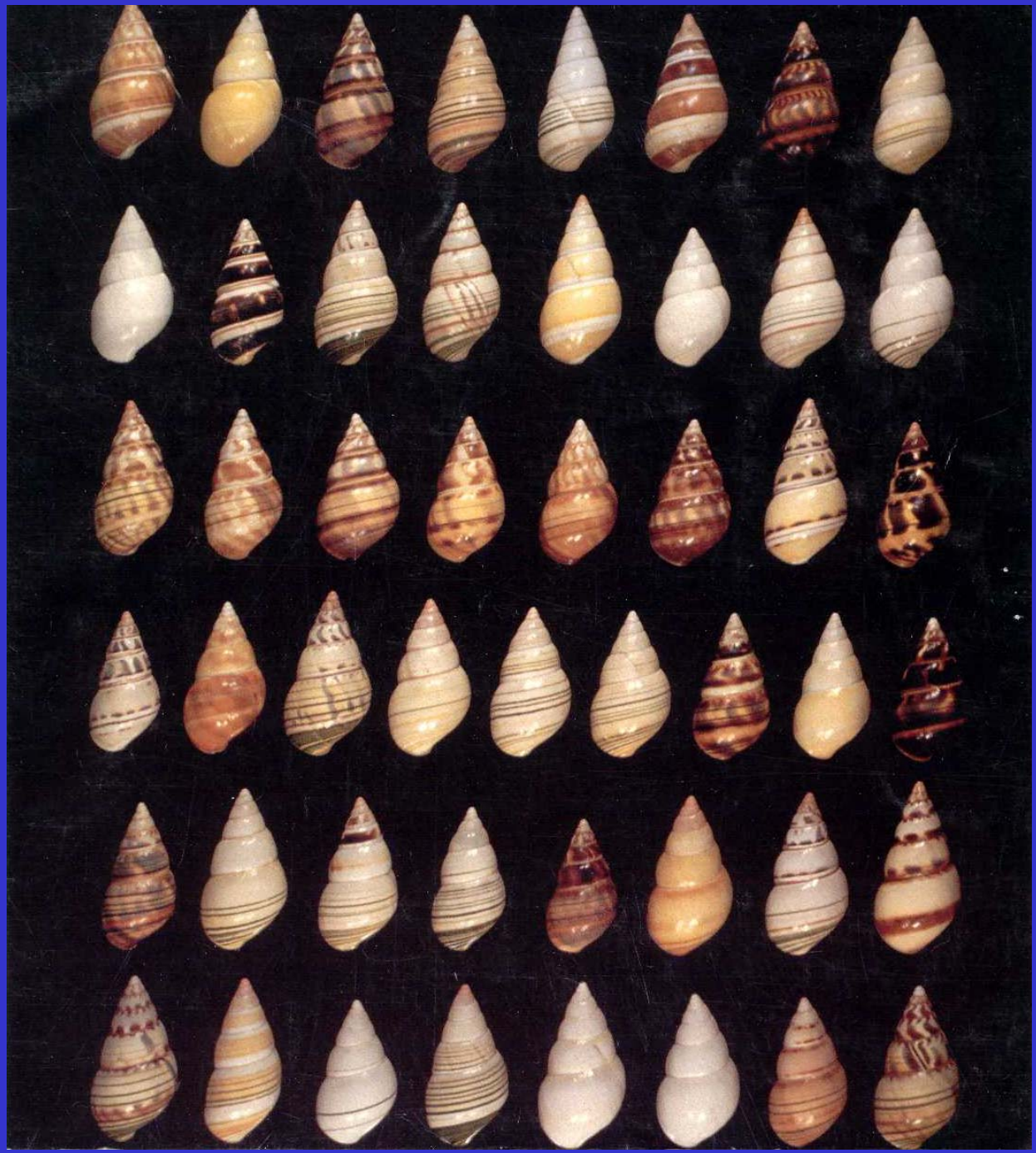


Plate 239
Ad
Imm
Ad
Ad
Black-fronted Bush-shrike
Ad
Ad
Many-coloured
Bush-shrike
Ad
Imm

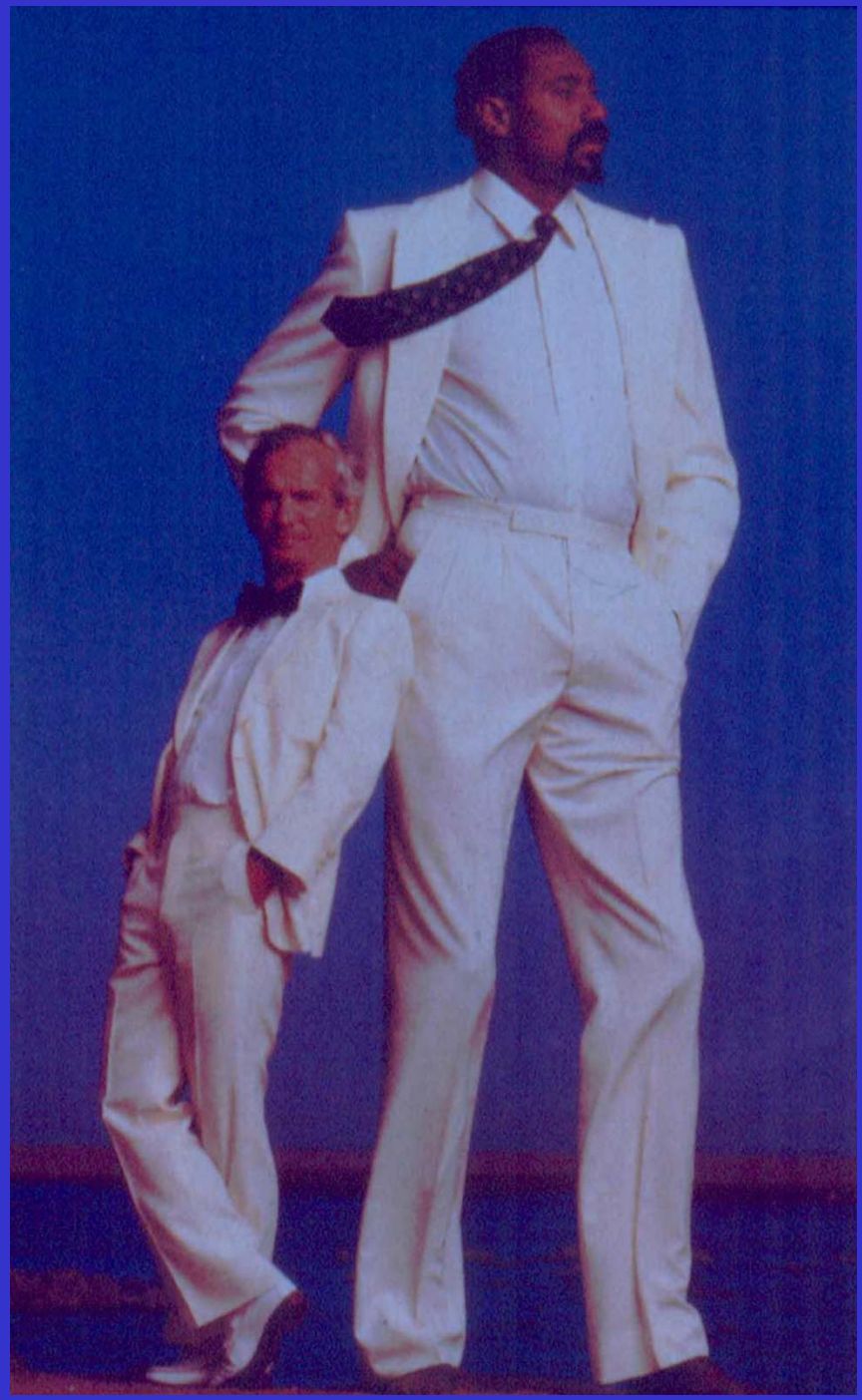


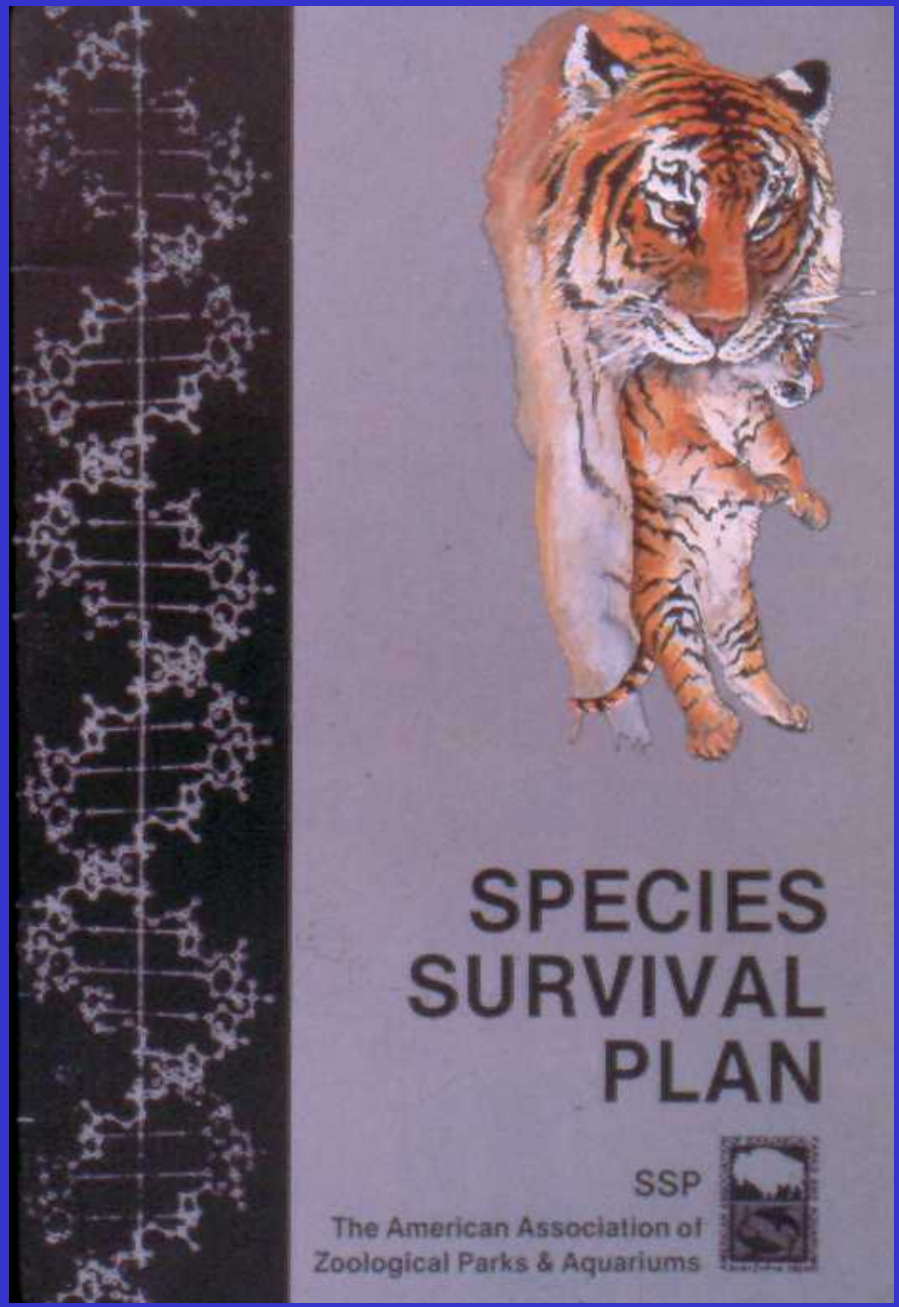
Florida tree snail

Tropical hardwood hammocks

Short tailed Hawk

How much variation is there?





Increasing role of genetics in conservation

The first conservation geneticist

THE VARIATION OF ANIMALS AND PLANTS UNDER DOMESTICATION

BY

CHARLES DARWIN, M. A., F. R. S., ETC.

CHAPTER XVII.

ON THE GOOD EFFECTS OF CROSSING, AND ON THE EVIL EFFECTS OF CLOSE INTERBREEDING.

DEFINITION OF CLOSE INTERBREEDING—AUGMENTATION OF MORBID TENDENCIES—GENERAL EVIDENCE OF THE GOOD EFFECTS DERIVED FROM CROSSING, AND ON THE EVIL EFFECTS FROM CLOSE INTERBREEDING—CATTLE, CLOSELY INTERBRED; HALF-WILD CATTLE LONG KEPT IN THE SAME PARKS—SHEEP—FALLOW-DEER—DOGS, RABBITS, PIGS—MAN, ORIGIN OF HIS ABHORRENCE OF INCESTUOUS MARRIAGES—FOWLS—PIGEONS—HIVE-BEES—PLANTS, GENERAL CONSIDERATIONS ON THE BENEFITS DERIVED FROM CROSSING—MELONS, FRUIT-TREES, PEAS, CABBAGES, WHEAT, AND FOREST-TREES—ON THE INCREASED SIZE OF HYBRID PLANTS, NOT EXCLUSIVELY DUE TO THEIR STERILITY—ON CERTAIN PLANTS WHICH EITHER NORMALLY OR ABNORMALLY ARE SELF-IMPOTENT, BUT ARE FERTILE, BOTH ON THE MALE AND FEMALE SIDE, WHEN CROSSED WITH DISTINCT INDIVIDUALS EITHER OF THE SAME OR ANOTHER SPECIES—CONCLUSION.

That any evil directly follows from the closest interbreeding has been denied by many persons; but rarely by any practical breeder; and never, as far as I know, by one who has largely bred animals which propagate their kind quickly. Many physiologists attribute the evil exclusively to the combination and consequent increase of morbid tendencies common to both parents; and that this is an active source of mischief there can be no doubt.

Charles Darwin (1898)

As some of our British parks are ancient, it occurred to me that there must have been long continued close interbreeding with the fallow deer (*Cervus dama*) kept in them; but on inquiry I find that it is a common practice to infuse new blood by procuring bucks from other parks.

Charles Darwin (1896, page 99)


Discourage
Inbreeding
BAN
COUNTRY
MUSIC

CONSERVATION GENETICS

(1) Management and reintroduction of captive populations, and the restoration of biological communities.

(2) Description and identification of individuals, genetic population structure, kin relationships, and taxonomic relationships.

(3) Detection and prediction of the effects of habitat loss, fragmentation, and isolation.

(4) Detection and prediction of the effects of hybridization and introgression.

(5) Understanding the relationships between adaptation or fitness and genetic characters of individuals or populations.

(6) Application of genetic markers to understand the basic biology of species and populations (including invasive species).

(7) Forensics.

(8) Application of genetic engineering to problems in conservation.

History of Conservation Genetics

N.I. Vavilov (1930 Russia)

Plant collections

Paavo Voipio (1950 Finland)

Game management

Sir Otto Frankel (1970 Australia)

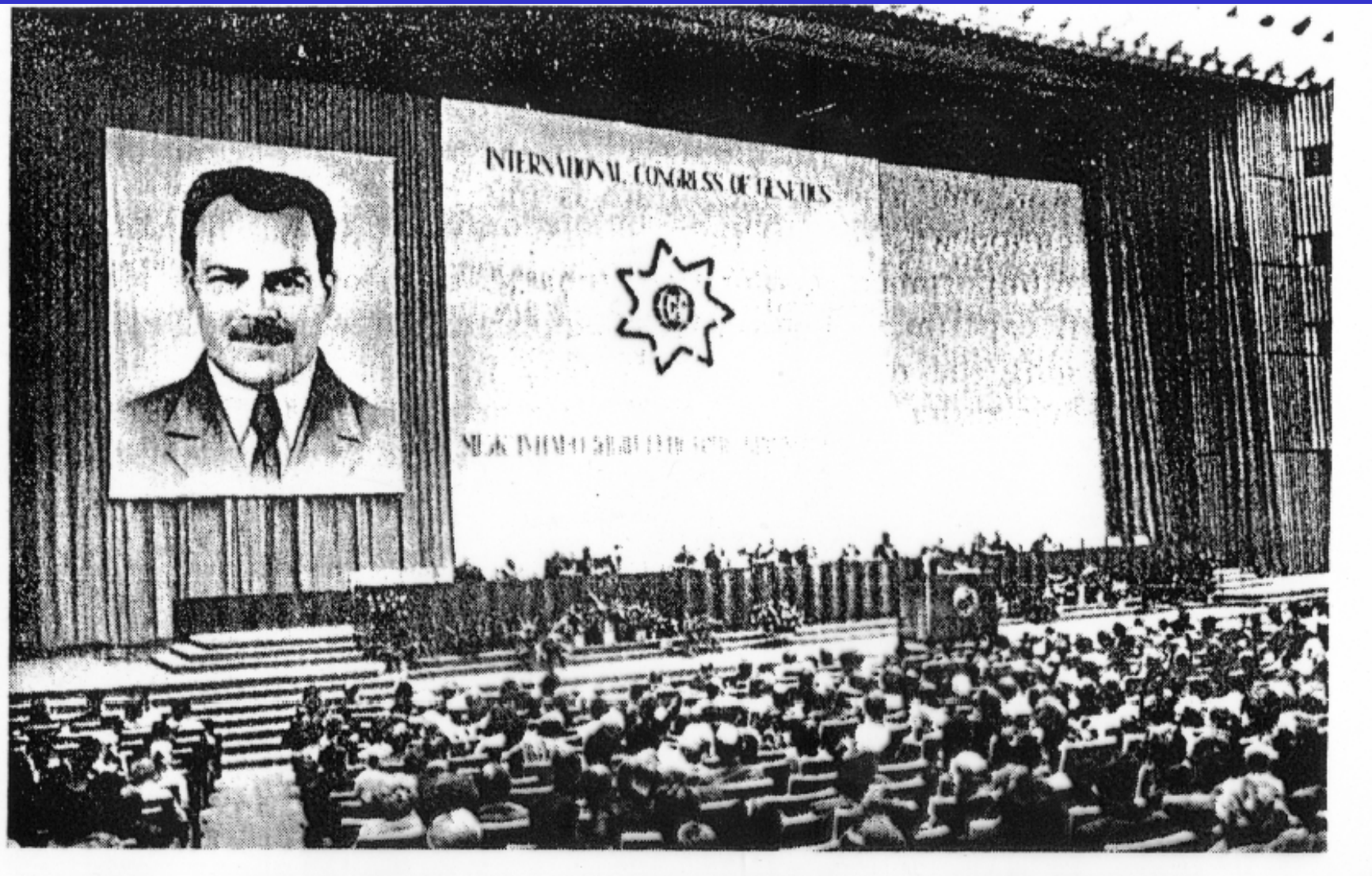
Preservation of agricultural diversity

Conservation of natural populations

Michael Soulé (1980 USA)

Founder of conservation biology

N.I. Vavilov (1930 Russia)



International Congress of Genetics 1978

RIISTATIETEELLISIÄ JULKAISUJA

PAPERS ON GAME RESEARCH

5

Evolution at the population level with special reference to game animals and practical game management

by

Paavo Voipio

To be presented, with the permission of the Section of Mathematics and Natural Sciences of the Philosophical Faculty of the University of Helsinki, for public criticism in Auditorium 12, October 21st, 1950, at 12 o'clock.

Symposium on Genetics and Society: XIII International Congress of Genetics

GENETIC CONSERVATION: OUR EVOLUTIONARY RESPONSIBILITY

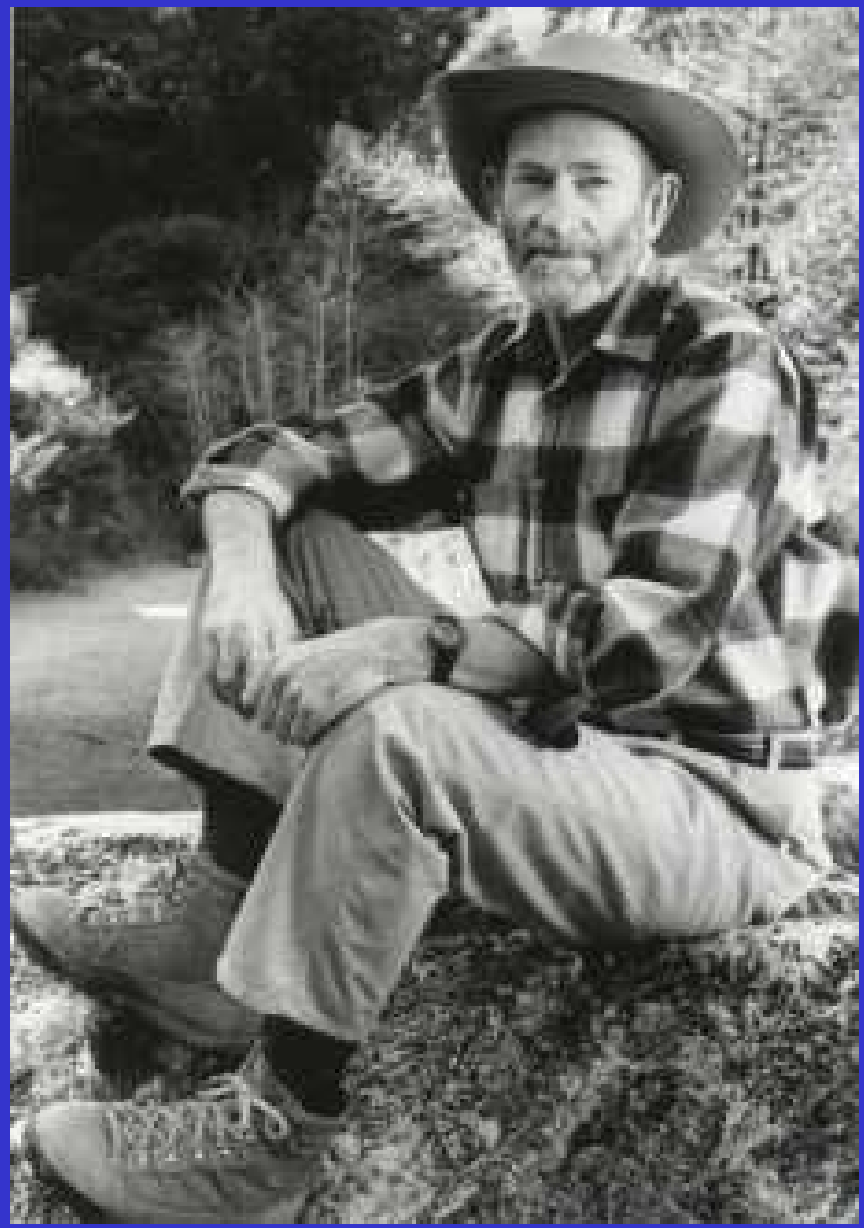
O. H. FRANKEL

CSIRO, Division of Plant Industry, P.O. Box 1600, Canberra City. A.C.T. Australia

The time scale of concern

	Period	Operator	Objective	Time scale
Wild-life	to 8,000 BC	hunter-gatherer	next meal	1 day
Domesticated plants	to 1850 AD	"primitive" or "traditional" peasant farmer	the next crop	1 year
	from 1850	plant breeder	the next variety	10 years
	from 1900	crop evolutionist	to broaden the genetic base	100 years
Wildlife	today	genetical conservationist	dynamic wildlife conservation	10,000 years +
		politician	current public interest	next election

Soulé, M. E., and Wilcox, B. M. (Editors). 1980. *Conservation Biology An Evolutionary - Ecological Perspective*. Sinauer, Sunderland, MA.



Participant Background Survey

There are many different molecular techniques (allozymes, mtDNA, microsatellites). What are the best methods for different questions?

How can results of genetic studies be misinterpreted?

Is a difference in chromosome number sufficient to make decisions in taxonomy at the species, subspecies, or population level?

When should groups be managed as separate populations versus increasing genetic exchange to avoid inbreeding depression?

How large does a population have to be to avoid detrimental genetic effects?

I am interested in developing a better understanding of evolutionarily significant units and distinct populations segments.

Understanding concepts of adaptation and evolution in species of invasive plants.

Conservation and the Genetics of Populations

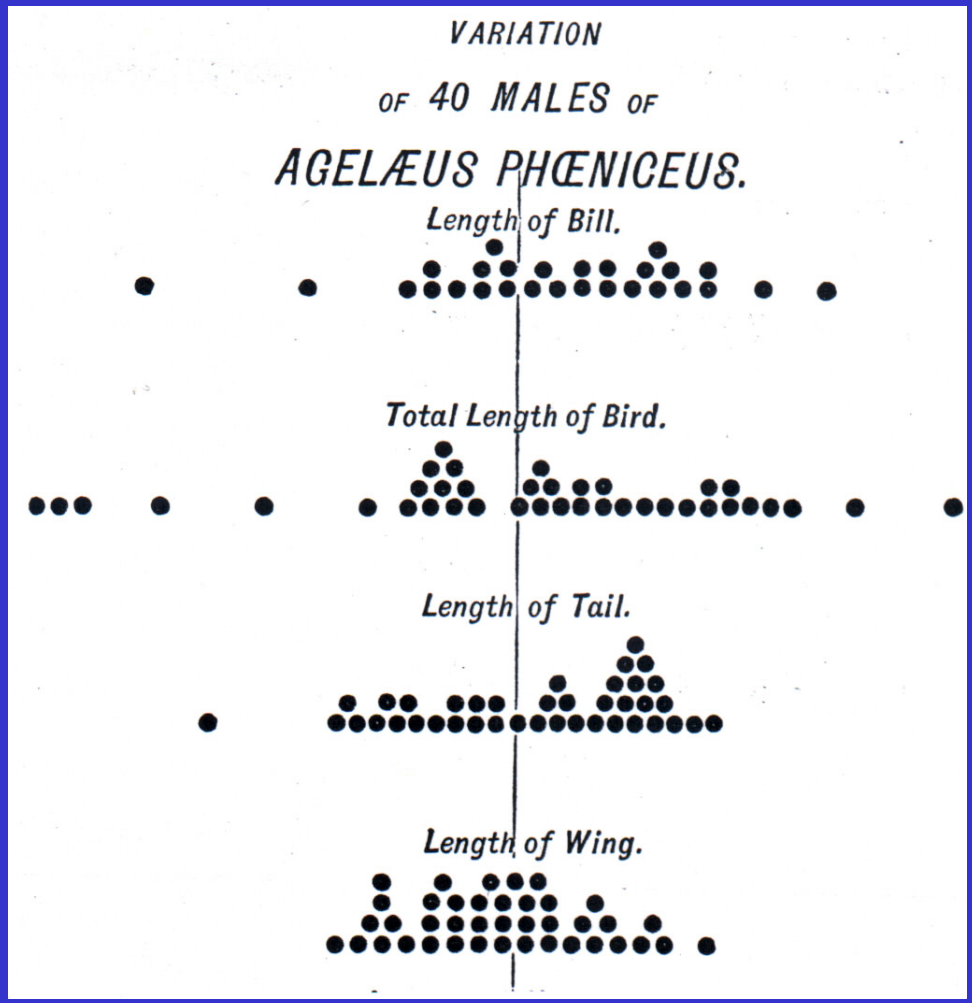
Fred W. Allendorf and Gordon H. Luikart

Conservation Genetics Joke of the Day

PHENOTYPIC VARIATION IN NATURAL POPULATIONS

Few persons consider how largely and universally all animals are varying. We know however, that in every generation, if we would examine all the individuals of any common species, we should find considerable differences, not only in size and color, but in the form and proportions of all the parts and organs of the body.

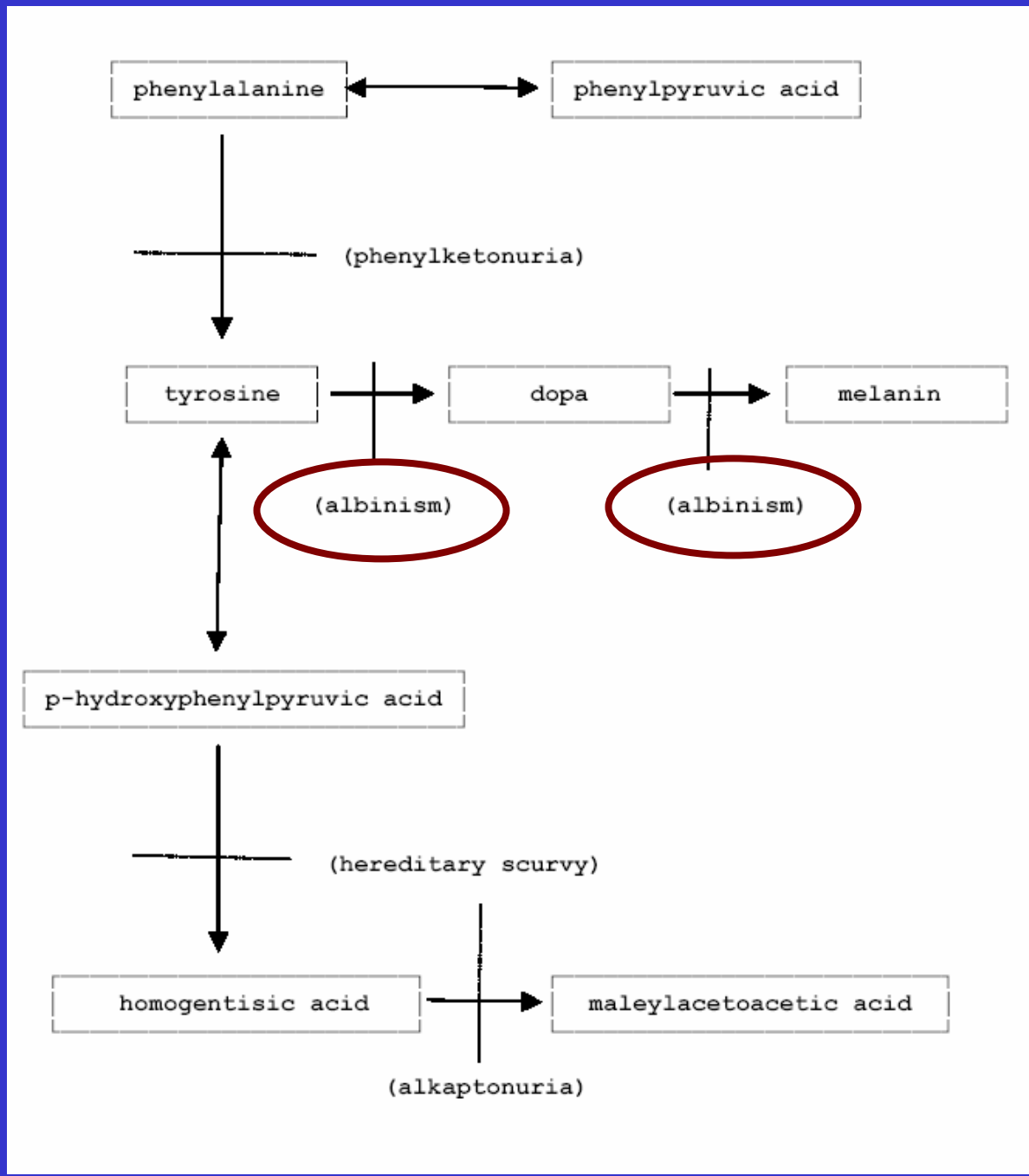
Alfred Russel Wallace



Red-winged blackbird

The many slight differences which appear in the offspring from the same parents, or which it may be presumed have thus arisen, from being observed in the individuals of the same species inhabiting the same confined locality, may be called individual differences. These individual differences are of the highest importance for us, for they are often inherited, as must be familiar to every one; and they thus afford materials for natural selection to act on and accumulate, in the same manner as man accumulates in any given direction individual differences in his domesticated productions. I am convinced that the most experienced naturalist would be surprised at the number of the cases of variability, even in important parts of structure, which he could collect on good authority, as I have collected, during a course of years. It should be remembered that systematists are far from being pleased at finding variability in important characters, and that there are not many men who will laboriously examine internal and important organs, and compare them in many specimens of the same species.

Darwin (OS,1858)


phenylalanine
phenylpyruvic acid
(phenylketonuria)
tyrosine
dopa
melanin
(albinism)
(albinism)
p-hydroxyphenylpyruvic acid
(hereditary scurvy)
homogentisic acid
maleylacetoacetic acid
(alkaptonuria)

Mating	Number of families	Progeny	
		Red	Gray
Red x red	8	23	5
Red x gray	46	68	63
Gray x gray	135	0	439

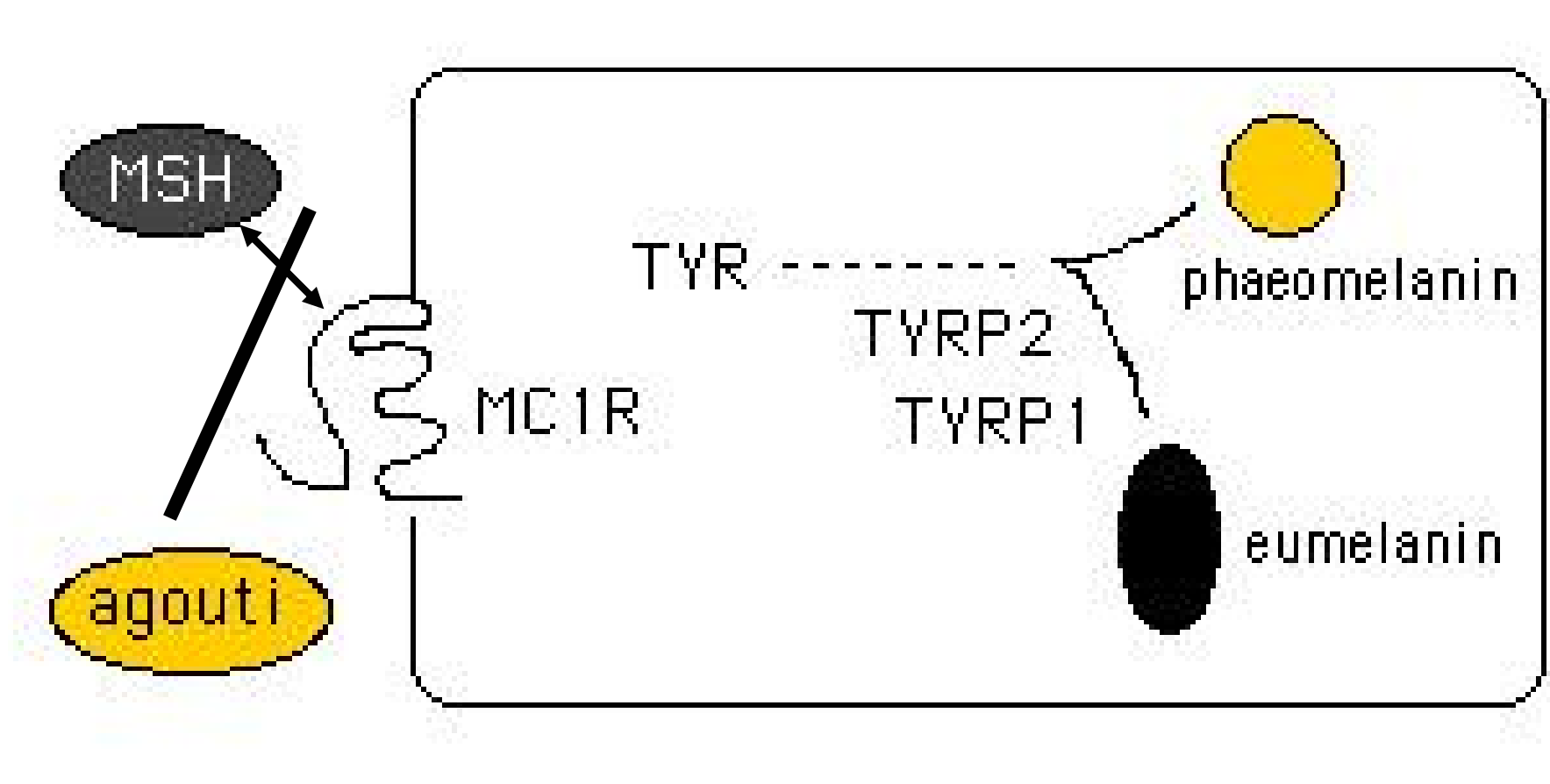
Eastern screech owl

Mating	Progeny		
	White	Blue	Total
White x white	35,104 (98%)	809 (2%)	35,913
White x blue	3,873 (40%)	5,691 (60%)	9,564
Blue x blue	1,064 (10%)	9,707 (90%)	10,771
Total	40,041	16,207	56,248

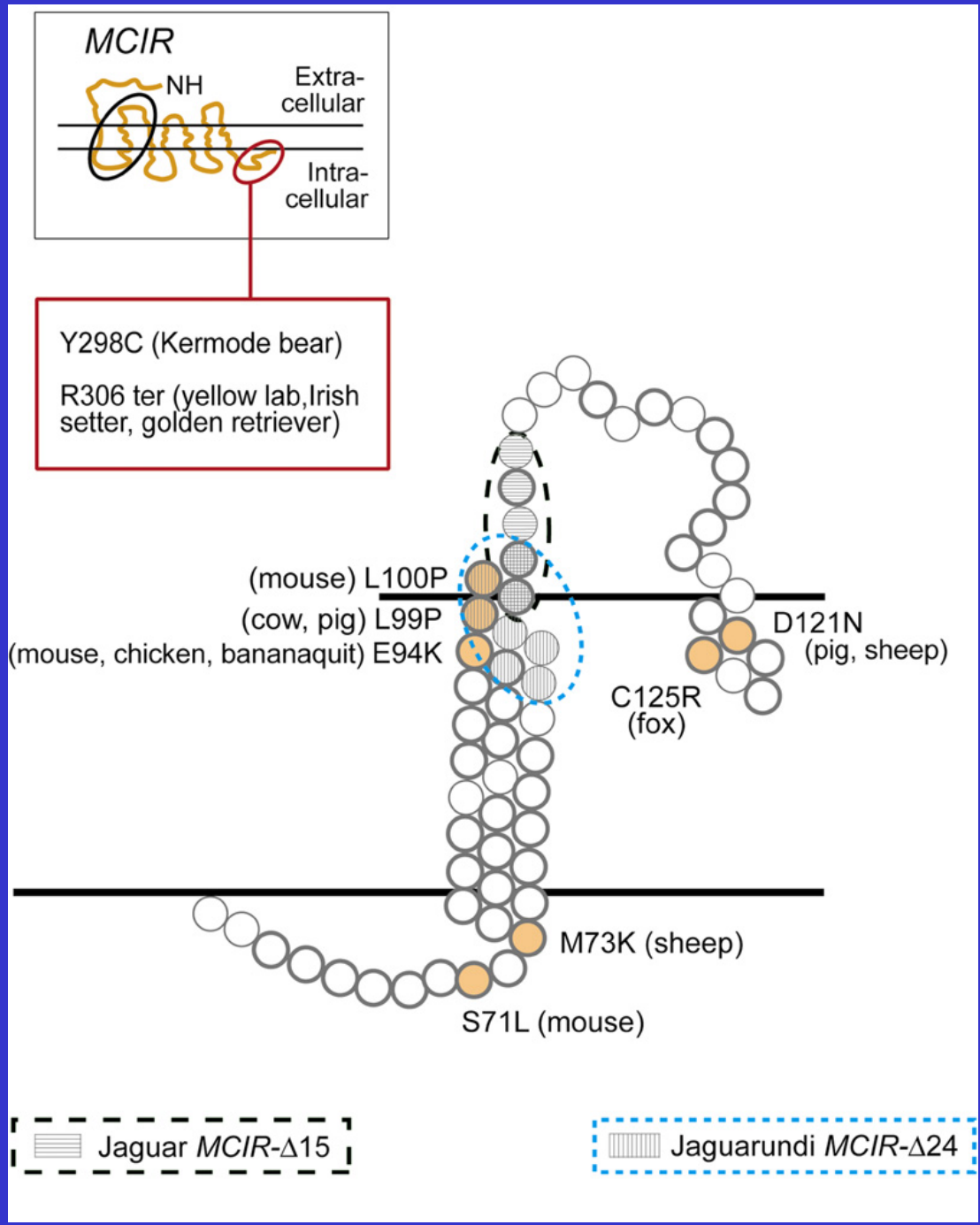
Cooke (1987)

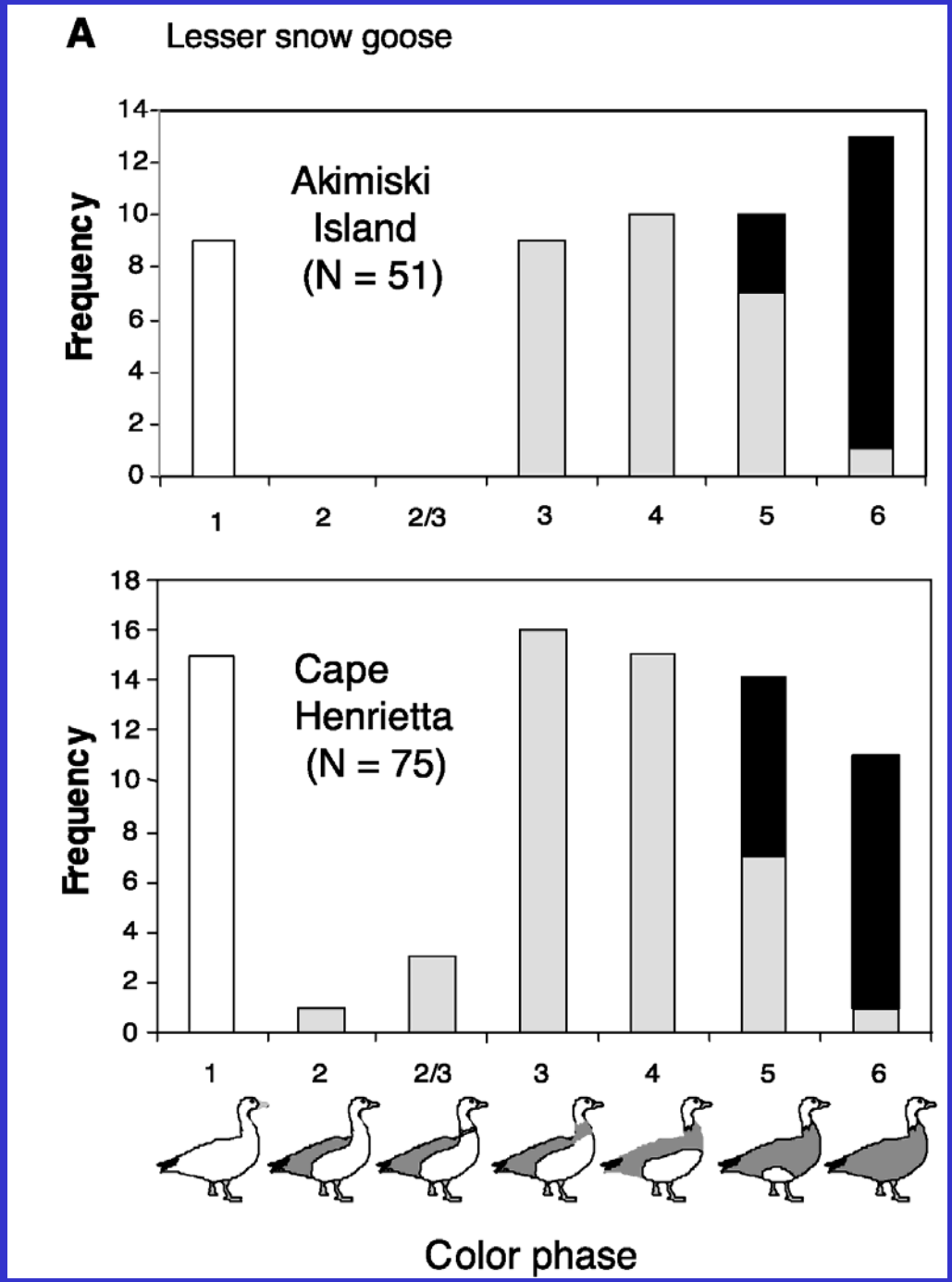
Snow geese

Melanocyte stimulating hormone

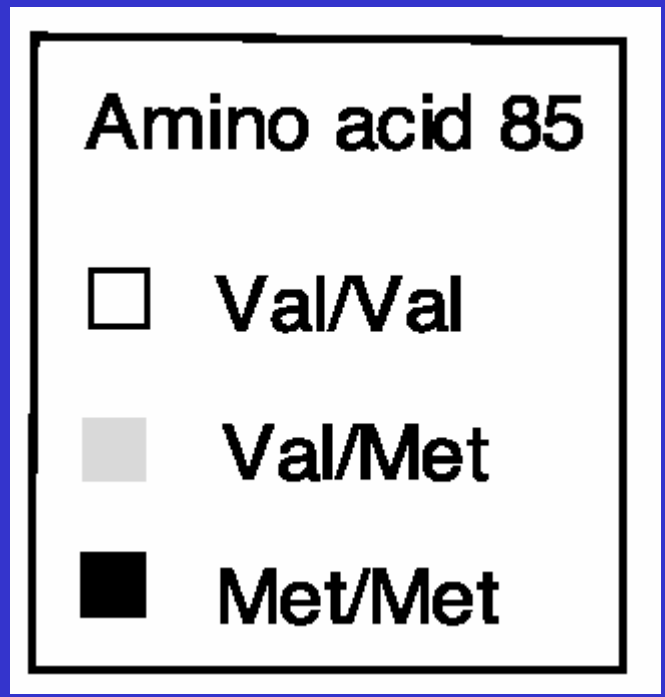


Melanocortin 1 receptor (*MC1R*)

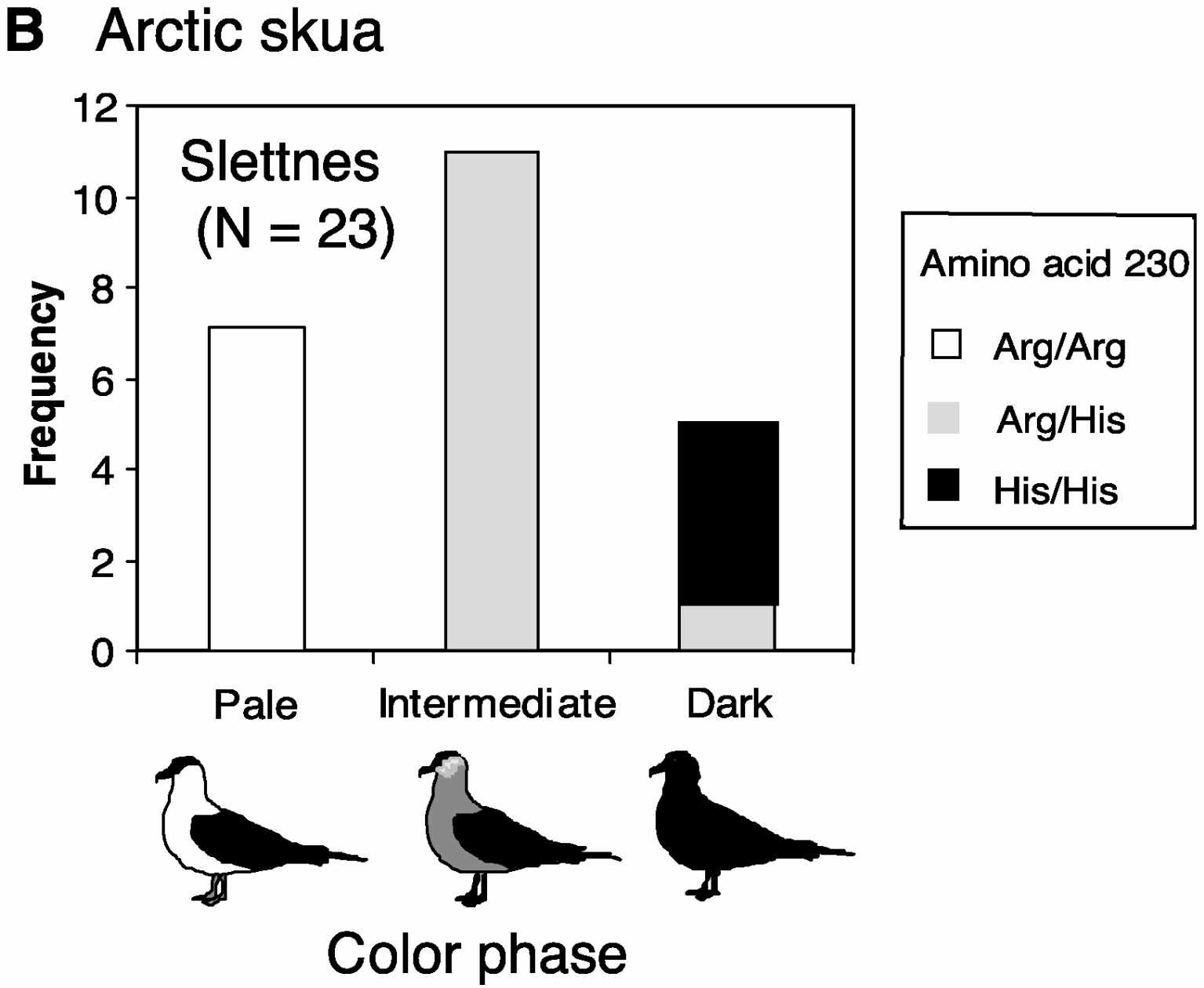

MCIR
NH
Extra-
cellular
Intra-
cellular
Y298C (Kermode bear)
R306 ter (yellow lab,Irish setter, golden retriever)
(mouse) L100P
(cow, pig) L99P
(mouse, chicken, bananaquit) E94K
D121N
(pig, sheep)
C125R
(fox)
M73K (sheep)
S71L (mouse)
Jaguar MCIR-Δ15
Jaguarundi MCIR-Δ24



Melanocortin-1 receptor (MC1R)



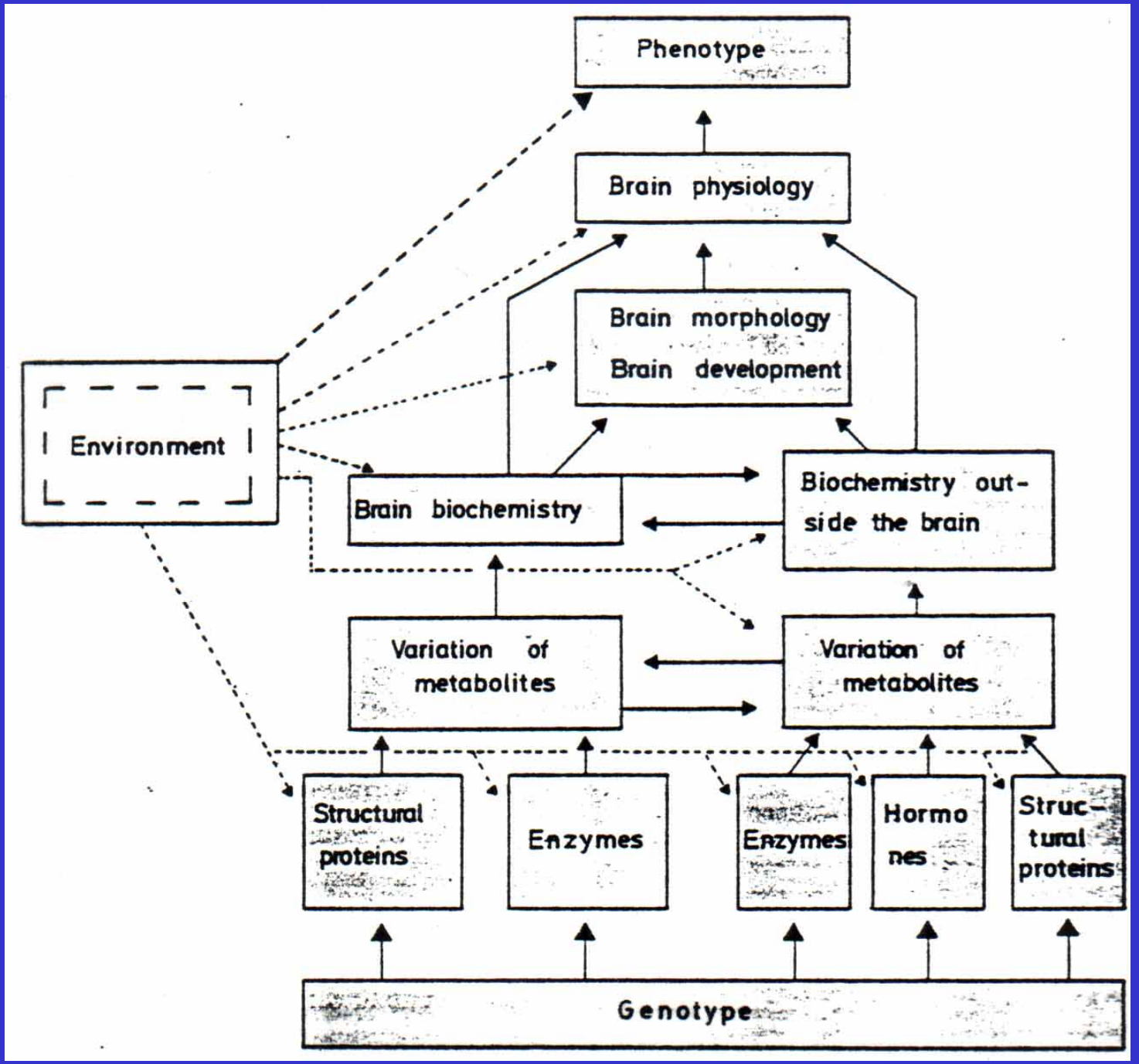
Mundy et al. 2004. Conserved genetic basis of a quantitative plumage trait involved in mate choice. Science 303:1870-1873.

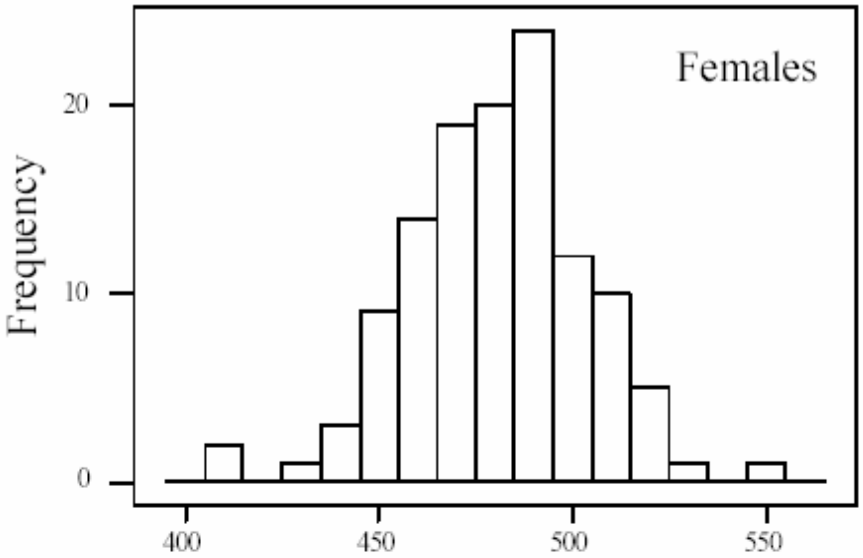

B Arctic skua
Slettnes
(N = 23)
Frequency
12
10
8
6
4
2
0
Pale
Intermediate
Dark
Color phase
Amino acid 230
Arg/Arg
Arg/His
His/His



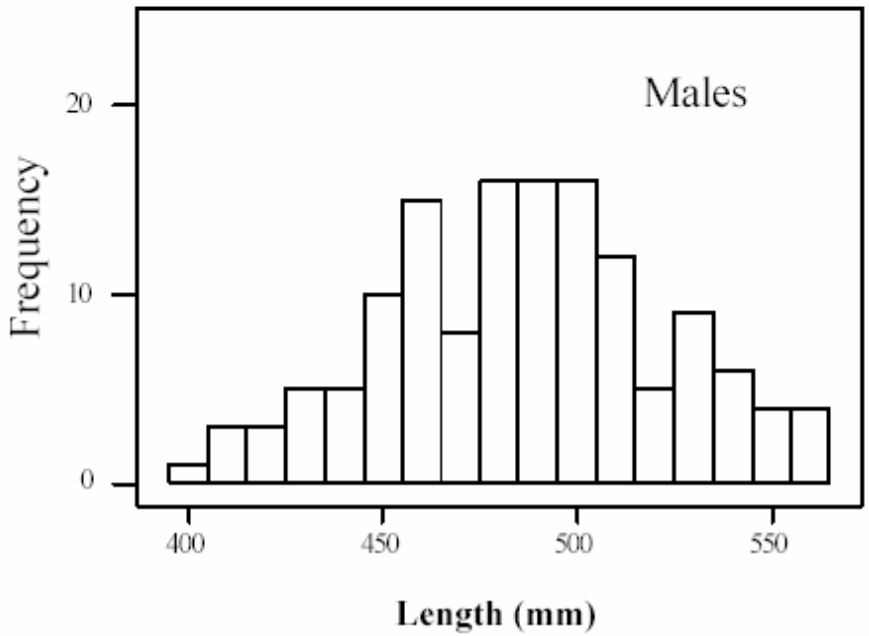

Rock pocket mouse

Nachman et al. 2003. The genetic basis of adaptive melanism in pocket mice. PNAS 100:5268.


Phenotype
Brain physiology
Brain morphology
Brain development
Environment
Brain biochemistry
Biochemistry out-
side the brain
Variation of
metabolites
Variation of
metabolites
Structural
proteins
Enzymes
Enzymes
Hormo
nes
Struc-
tural
proteins
Genotype

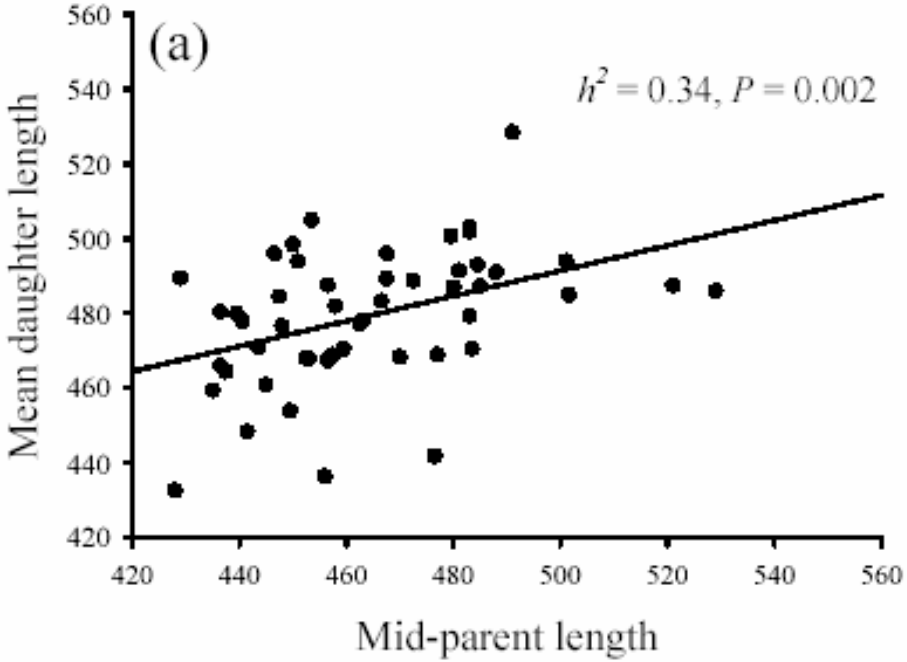

Females
Frequency
20
10
0
400
450
500
550

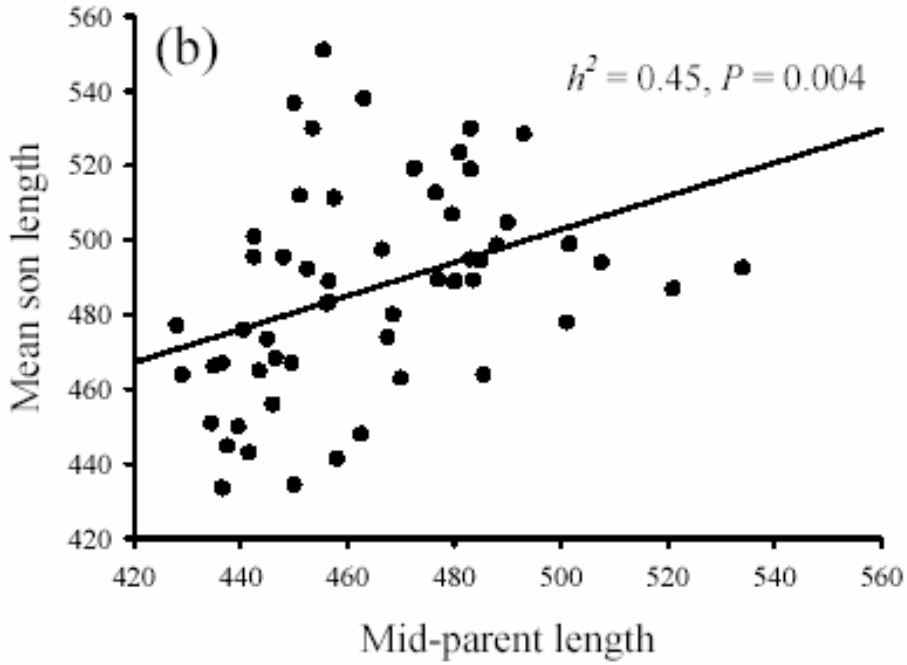
Pink salmon


Males
Frequency
20
10
0
400
450
500
550
Length (mm)

$$V_P = V_G + V_E$$

$$\text{Heritability} = V_G / V_P$$


(a)
$h^2 = 0.34, P = 0.002$
Mean daughter length
Mid-parent length
560
540
520
500
480
460
440
420
420
440
460
480
500
520
540
560


(b)
$h^2 = 0.45, P = 0.004$
Mean son length
Mid-parent length
560
540
520
500
480
460
440
420
420
440
460
480
500
520
540
560

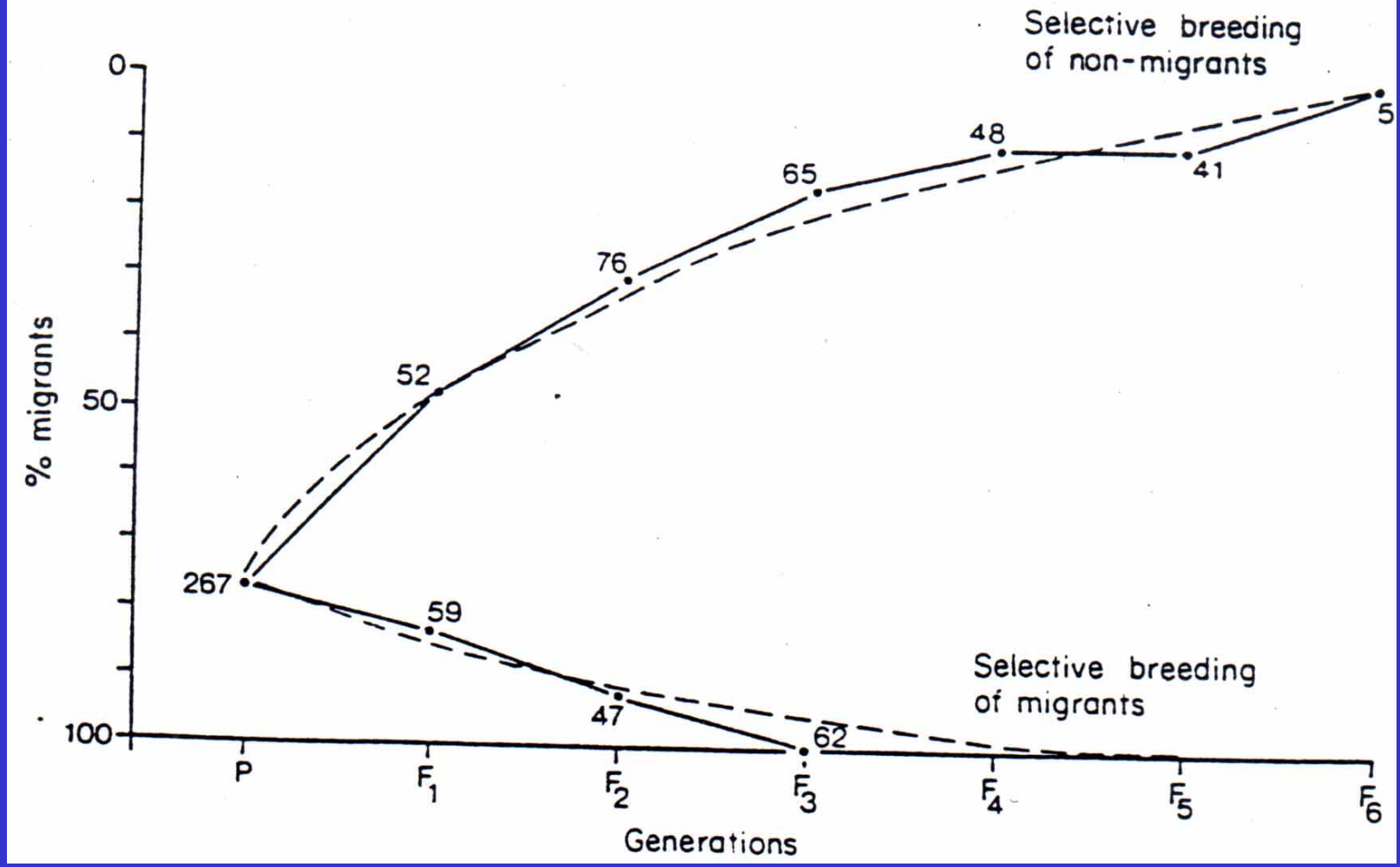
Behavior

So in regard to mental qualities, their transmission is manifest in our dogs, horses, and other domestic animals. Besides special tastes and habits, general intelligence, courage, bad and good temper, etc., are certainly transmitted.

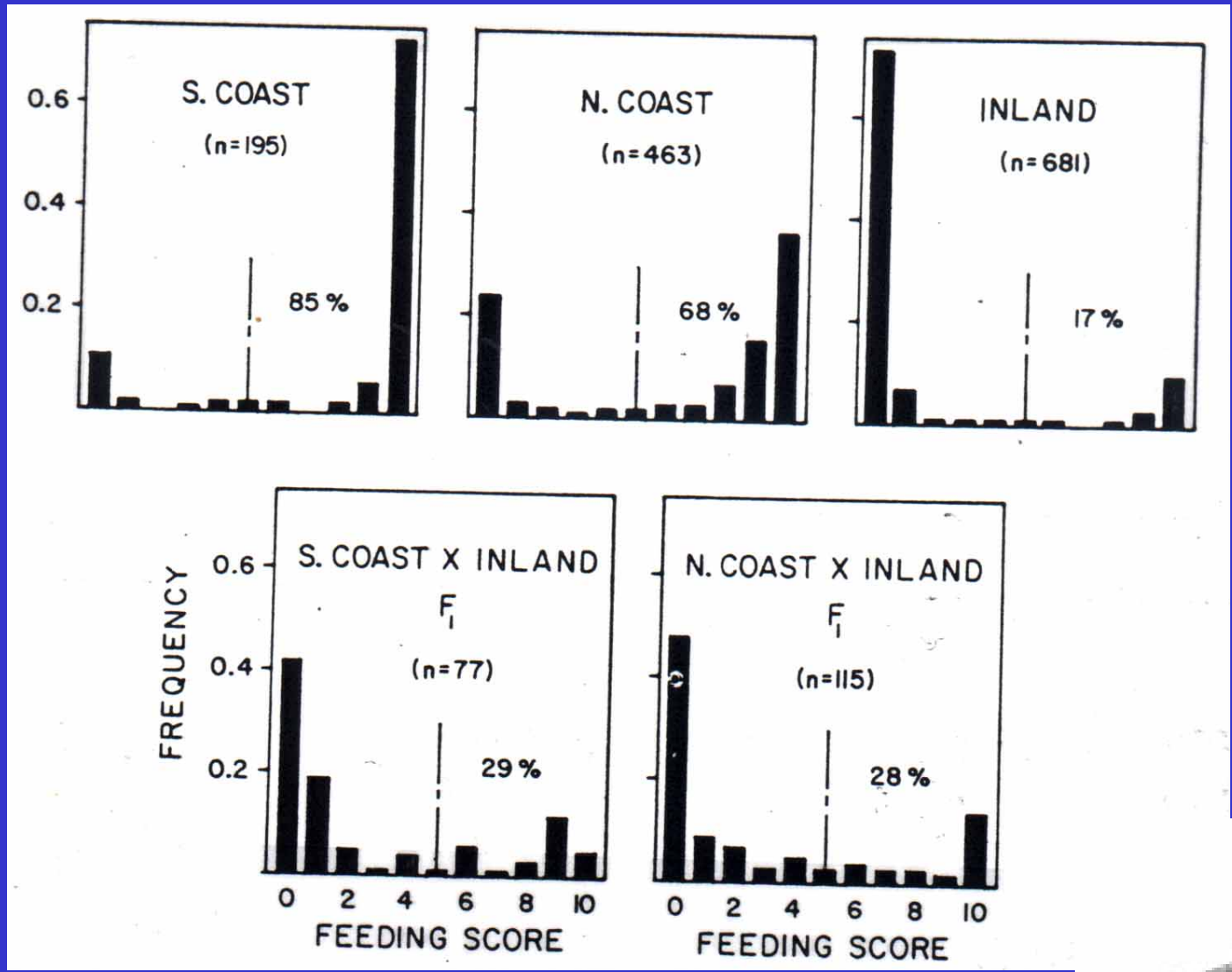
Darwin (1871)

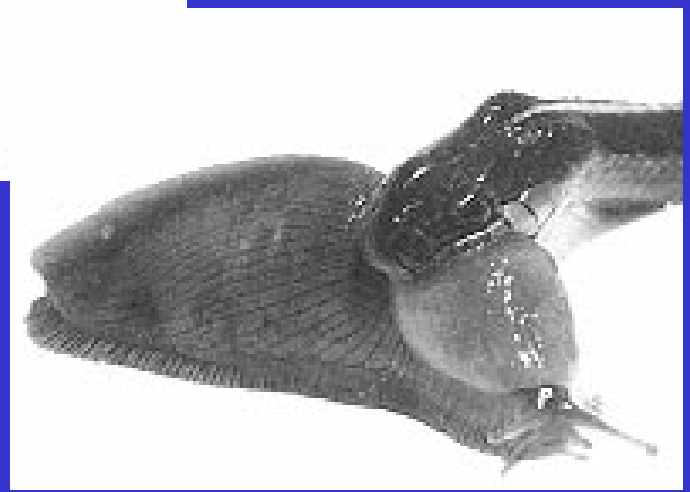
A variety of behaviors have been found to be heritable in dogs. The following table shows estimates of heritability in Australian dogs.

Trait	Heritability
Nervousness	0.58
Concentration	0.28
Willingness	0.22
Sound-shy	0.14
Body sensitivity	0.33


Selective breeding
of non-migrants
0
50
100
% migrants
267
52
76
65
48
41
5
59
47
62
Selective breeding
of migrants
P
F1
F2
F3
F4
F5
F6
Generations

Black-caps

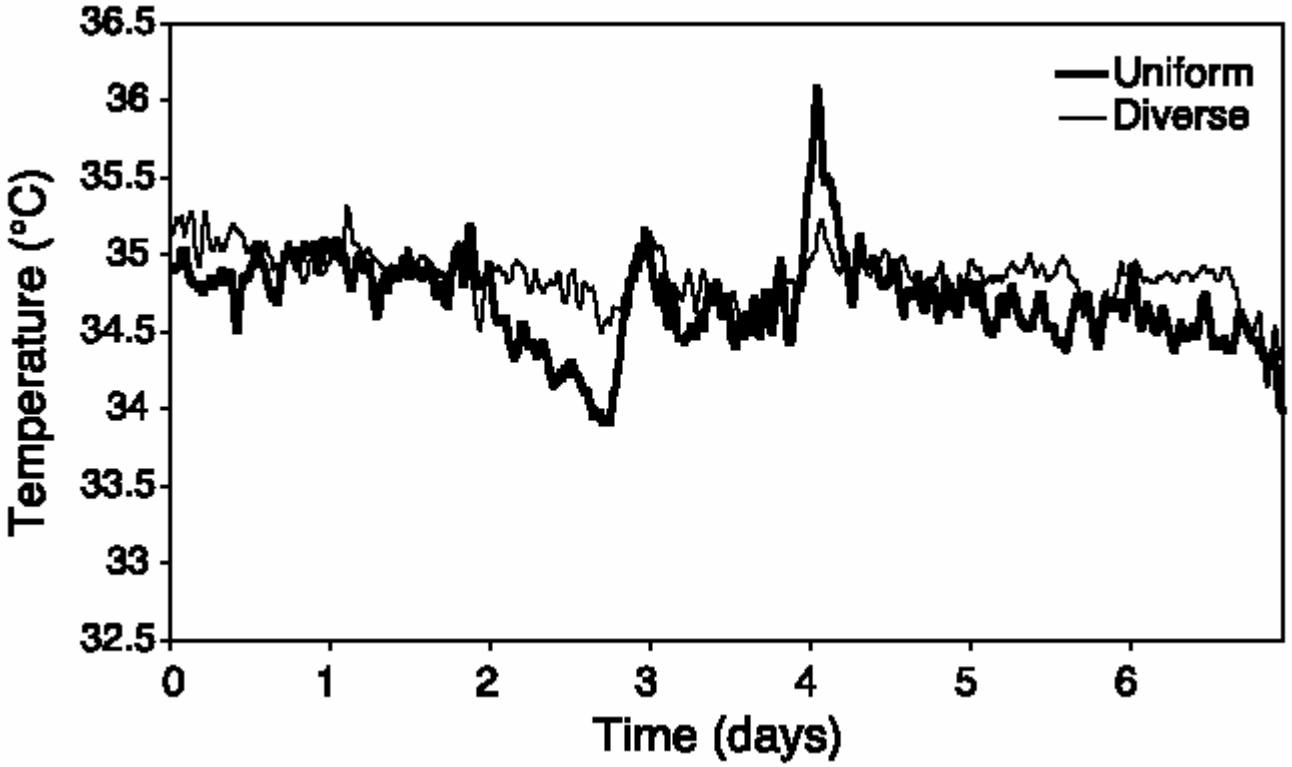

S. COAST
(n=195)
85 %
N. COAST
(n=463)
68 %
INLAND
(n=681)
17 %
S. COAST X INLAND
F1
(n=77)
29 %
N. COAST X INLAND
F1
(n=115)
28 %
FREQUENCY
0.6
0.4
0.2
0 2 4 6 8 10
FEEDING SCORE
0 2 4 6 8 10
FEEDING SCORE



Honey Bee Nest Thermoregulation: Diversity Promotes Stability

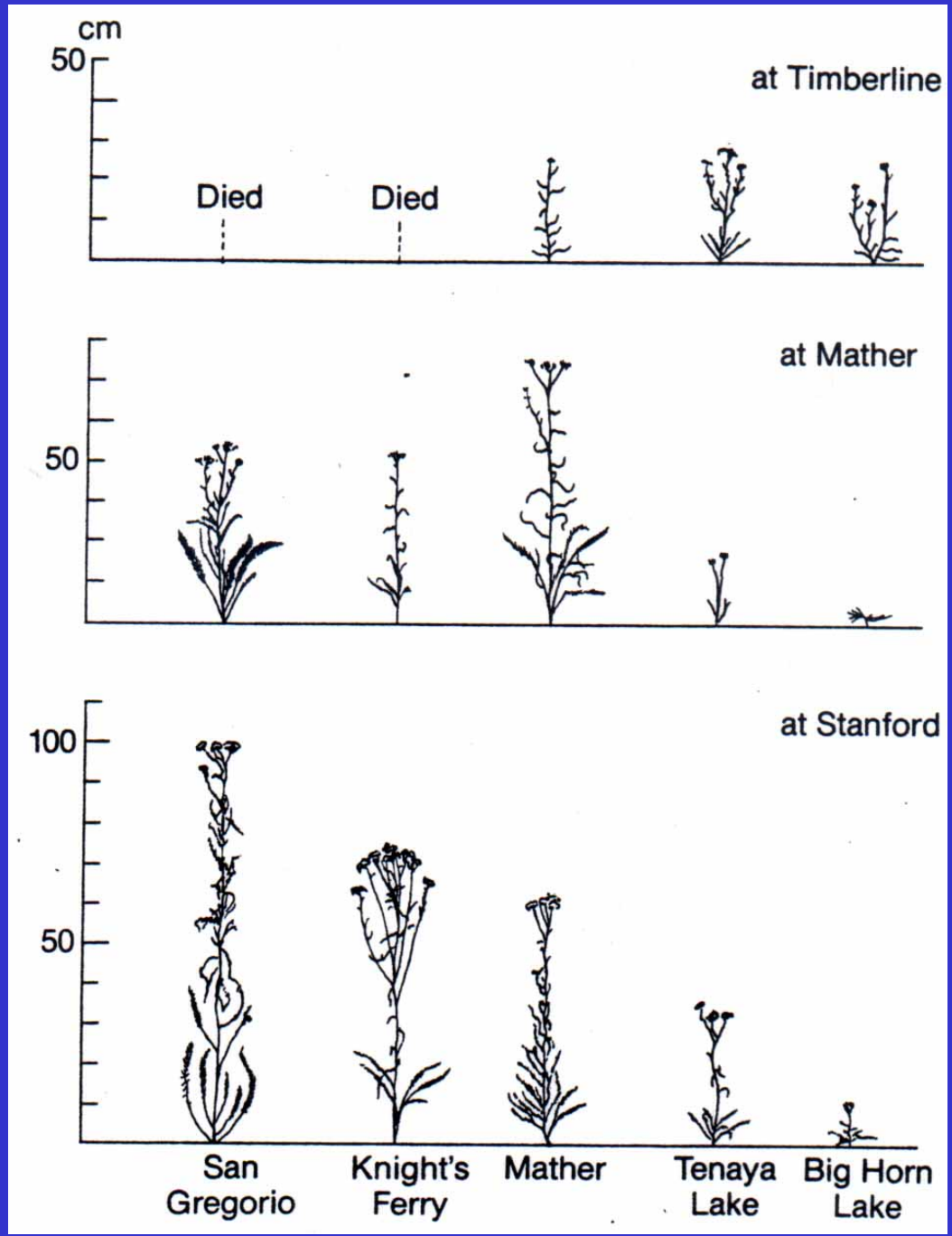
Julia C. Jones,[1]* Mary R. Myerscough,[2] Sonia Graham,[2]
Benjamin P. Oldroyd[1]

Science 305:402-404. 2004.

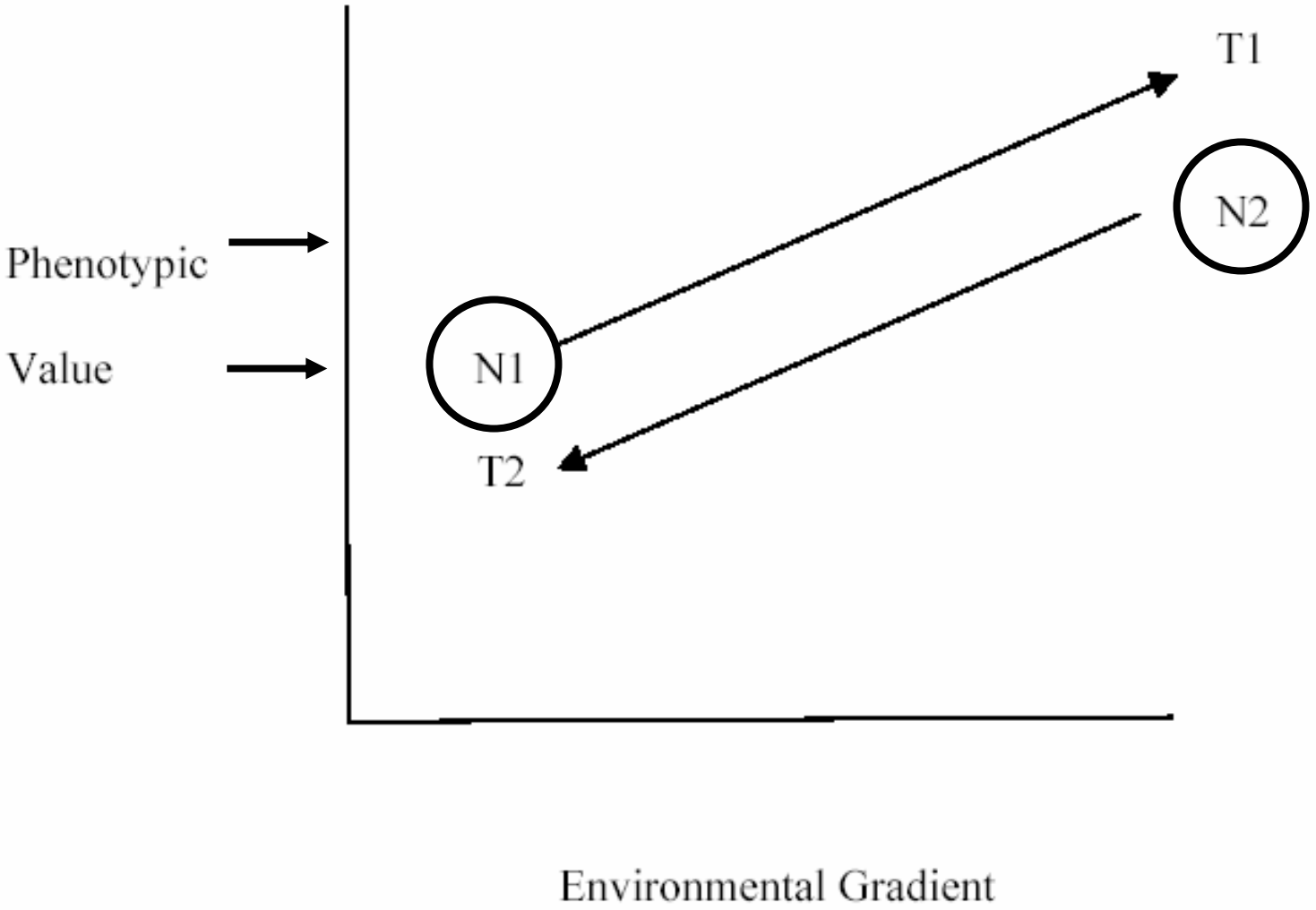


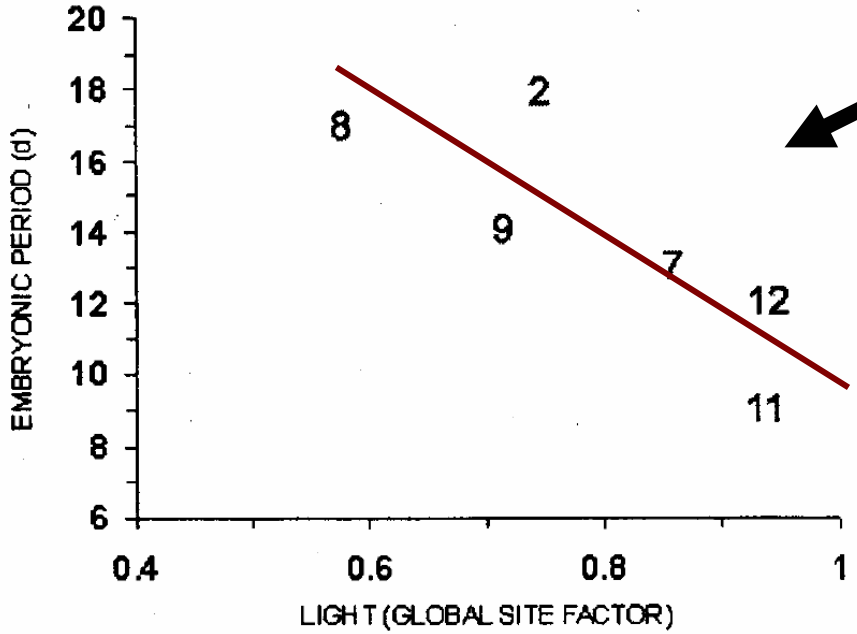
Differences among populations

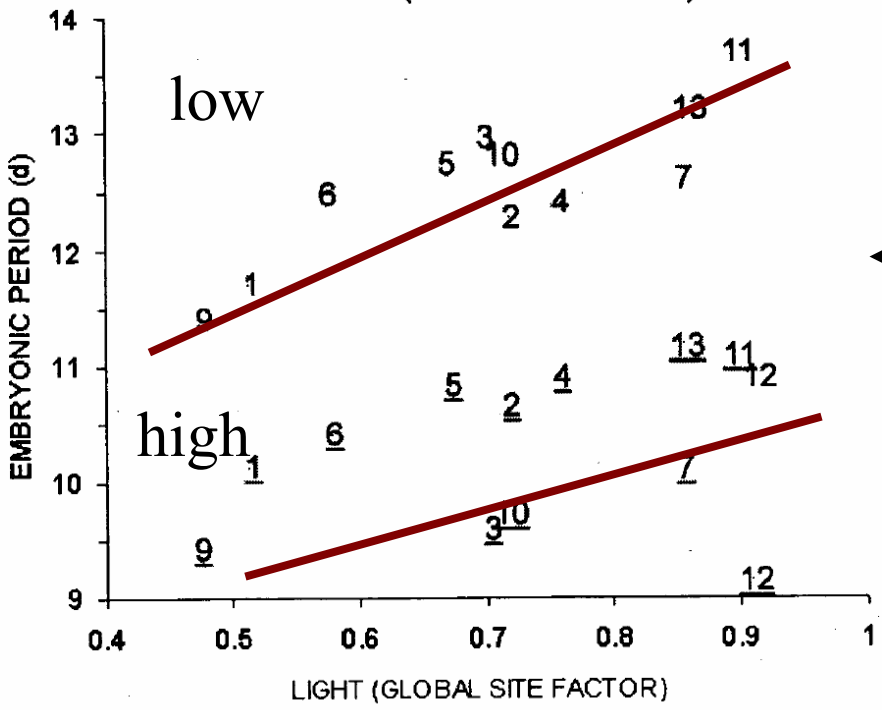
Common garden experiments



Countergradient Variation (Looks can be deceiving)





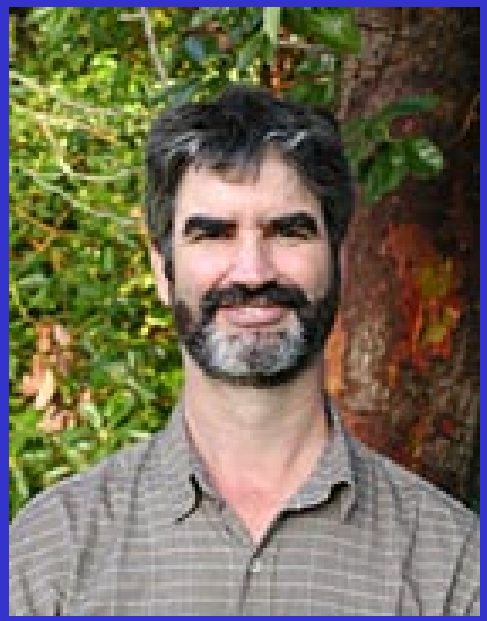


In nature

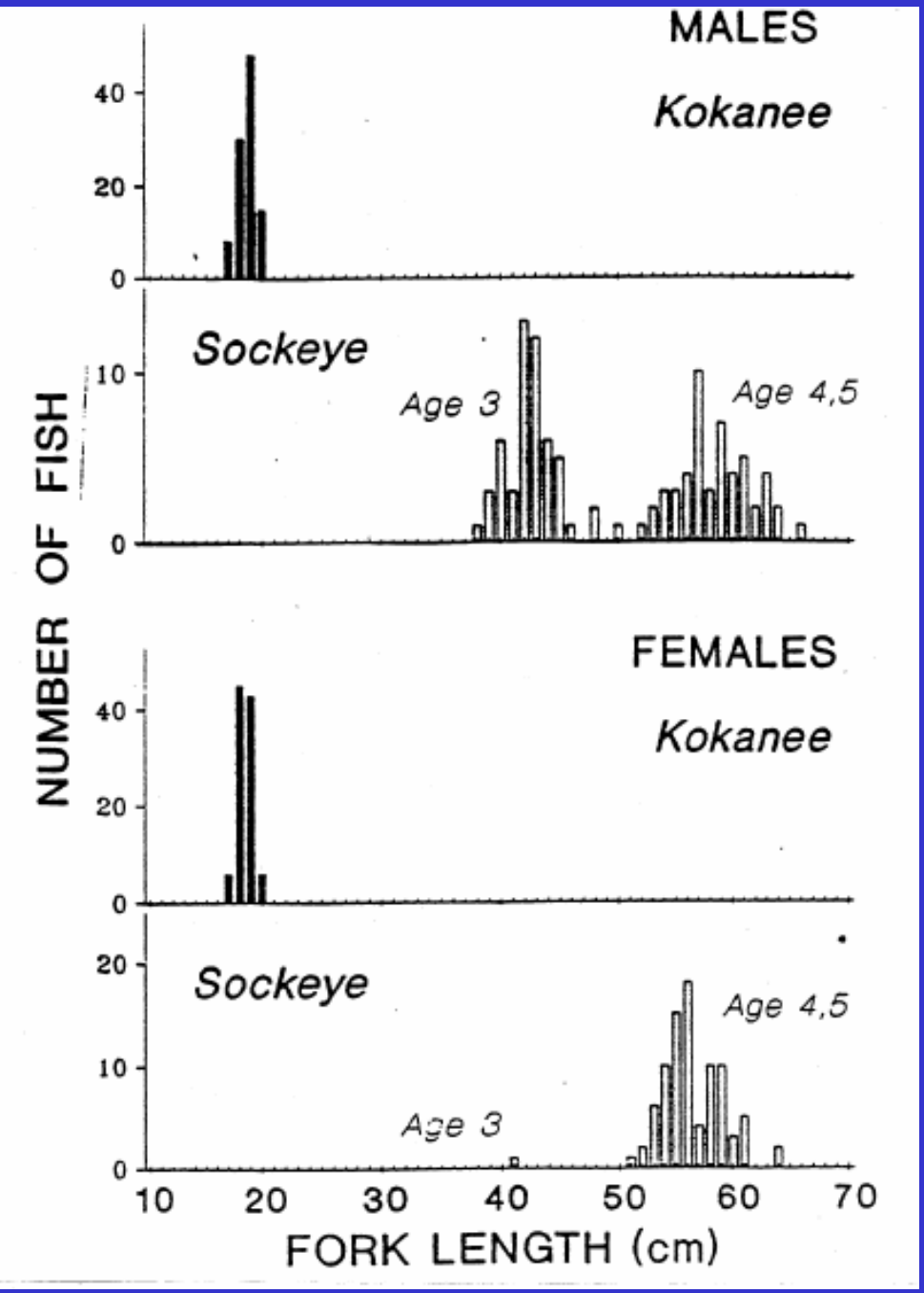
Wood frog

In laboratory

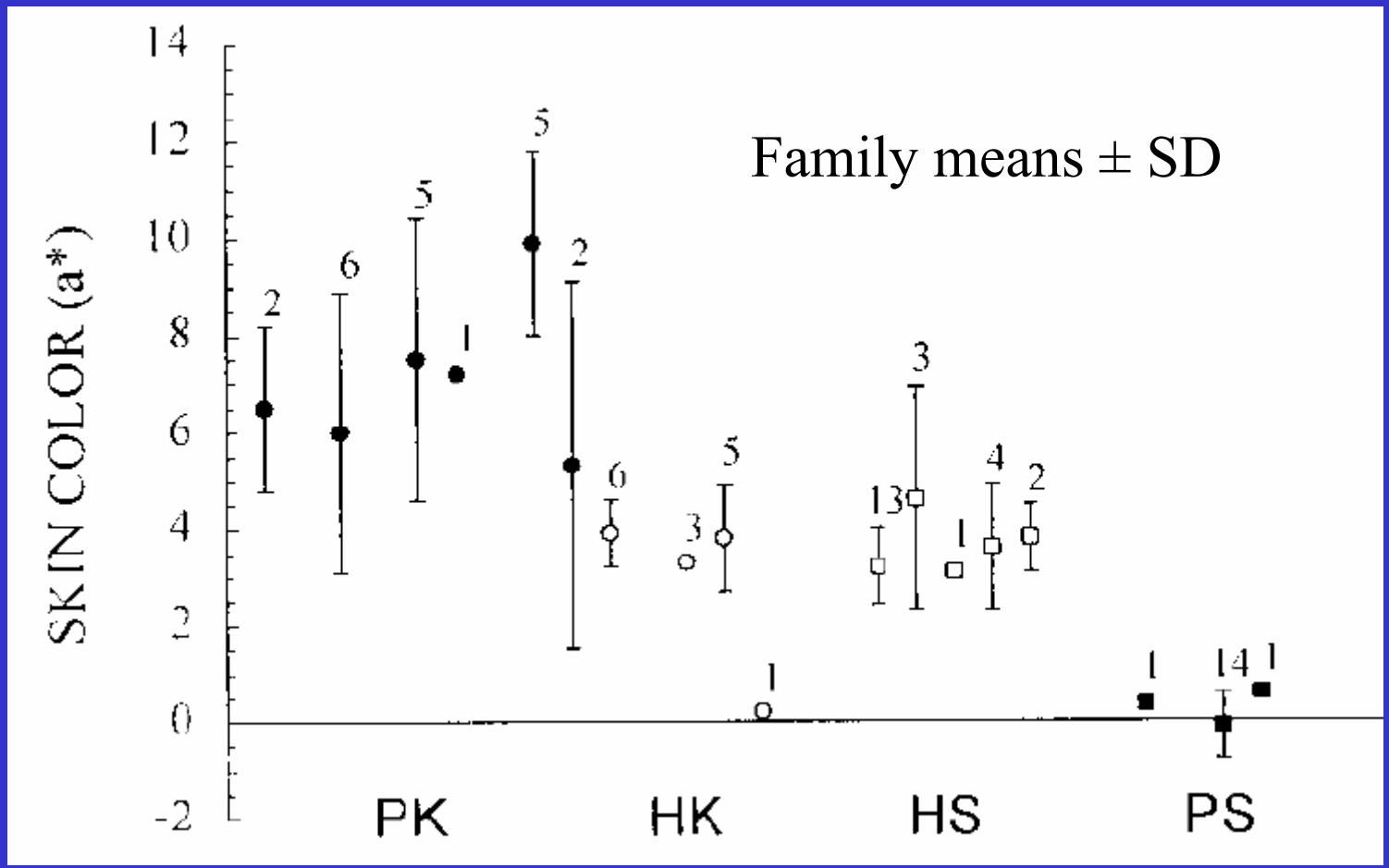
Skelly, D. K. 2004. Microgeographic countergradient variation in the wood frog, *Rana sylvatica*. Evolution 58:160-165.



Guest Box 2;
Chris Foote


MALES
Kokanee
Sockeye
Age 3
Age 4,5
FEMALES
Kokanee
Sockeye
Age 4,5
Age 3
NUMBER OF FISH
FORK LENGTH (cm)
0
10
20
30
40
50
60
70

Common garden (tank) experiment



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